96-102

U.S. Department
of Transportation
Federal Highway Administration

400 Seventh St., S.W.
Washington, D.C. 20590

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JUL 12 1996

Mr. William Caton
The Secretary
Federal Communications Commission
1919 M Street, NW., Room 222
Washington, D.C. 20554

RECEIVED
JUL 15 1996
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

Re: Amendment of the Commission's
Rules to Provide for
Unlicensed NII/SUPERNet
Operations in the 5 Ghz Frequency Range

Dear Mr. Caton:

Please find our attached comments on the subject Notice of Proposed Rule Making. We feel the concepts addressed in this docket are worthwhile and represent a step forward in providing the high bandwidth, local area applications necessary to ensure many benefits to the country. We are concerned, though, that there are other near term applications, namely Dedicated Short Range Communication systems for Intelligent Transportation Systems, which may be impacted. At this stage there is the opportunity to examine this issue in depth and develop appropriate mechanisms, both technical and regulatory, to ensure adequate spectrum support for both applications. The attached comments provide further detail on this issue.

Should you have any questions regarding this submittal, please contact Mr. George Beronio at (202) 366-6111 or Mr. Jim Arnold at (703) 285-2974.

Sincerely yours,

Christine M. Johnson
Director, ITS Joint Program Office

Attachment

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cc: BJones, Cjohnson, Brussell(HCC-32)
Psmith (C-30), Sfrodge (P-6)
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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	ET Docket No. 96-102
	)	RM-8648
Amendment of the Commission's Rules	)	RM-8653
to Provide for Unlicensed	)	
NII/SUPERNet Operations in the 5 GHz	)	
Frequency Range	)	

COMMENTS OF THE FEDERAL HIGHWAY ADMINISTRATION ON UNLICENSED NII/SUPERNET OPERATION IN THE 5 GHZ RANGE NOTICE OF PROPOSED RULE MAKING

Submitted: July 15, 1996

Submitted by: The Federal Highway Administration

I. INTRODUCTION

As a whole, the Federal Highway Administration (FHWA) feels that the National Information Infrastructure (NII)/Shared Unlicensed Personal Radio Network (SUPERNet), proposed by Apple Computer, Inc. and the Wireless Information Networks Forum (WINForum), is a sound concept with many benefits to the public community and commercial sector. Society is moving forward in the world of wireless data as indicated by the rollout of Cellular Digital Packet Data (CDPD), terrestrial Personal Communication Services (PCS), and Low-earth Orbit (LEO) satellite systems. Still, high bandwidth, local area applications (e.g., High Performance Radio LAN (Hyperlan)) cannot be satisfied unless additional spectrum is made available.

NII/SUPERNet applications are not the only operations which are in need of spectrum and are looking toward the 5 GHz band to meet that requirement. A national effort is currently in progress to develop Intelligent Transportation System (ITS) infrastructure throughout the United States. As part of this effort, Dedicated Short Range Communications (DSRC) will play an integral part in supporting safety critical needs. Although NII/SUPERNet devices may be used to support some ITS applications, they are geared for a common user environment and will not be suitable for safety-critical operations. Such applications need guaranteed channel access, something not found in the proposed NII/SUPERNet implementation. A separate DSRC

allocation is necessary to support this role. ITS America, a nonprofit organization dedicated to the deployment of ITS, is presently developing a petition for an allocation in the 5.850-5.925 GHz band for DSRC operations. This petition will be forthcoming in the near future. The FHWA supports this action and has committed technical resources to assist in the preparation of this petition.

5.8 GHz makes sense for DSRC because Radio Frequency (RF) propagation characteristics support high frequency reuse, the users currently in the band are very compatible with DSRC, and there are manufacturers currently building DSRC equipment to operate in this region of the spectrum.

If both the NII/SUPERNet and ITS allocation proposals were ultimately granted, there would be an overlap in frequency from 5.850 to 5.875 GHz. It appears likely that some subset of services can co-exist in this part of the frequency spectrum, but further investigation is needed to verify this. FHWA has a specific concern that mobile NII/SUPERNet devices may interfere with DSRC operations. Also, if NII/SUPERNet devices are allowed to utilize more than -10 dBW (0.1 watt), coexistence with DSRC will be difficult. We recommend that the Federal Communications Commission (FCC) NOT make a ruling on the 5.850 - 5.875 portion of the band until compatibility investigations are complete.

II. DISCUSSION

At 5.8 GHz, the nature of RF propagation is such that communications are generally localized. This means that in most instances NII/SUPERNet and DSRC users can operate within the same frequency region as long as they are not in the immediate vicinity of each other and neither utilize high effective isotropic radiated power (EIRP). Preliminary analysis shows that NII/SUPERNet devices may disrupt some DSRC services if they are within 60 meters of a reader antenna (see attachment). As more information is made available about NII/SUPERNet transceiver characteristics, more detailed analysis will be possible. FHWA is taking steps to work cooperatively with Apple and WINForum on this issue.

If the FCC decides to proceed with the 5.850-5.875 GHz frequency allocation before compatibility analysis is complete, we suggest the following based upon the preliminary analysis in the attachment: (1) Within the Notice of Proposed Rule Making (NPRM), ET Docket No. 96-102, the FCC proposes limiting peak EIRP of NII/SUPERNet devices to -10 dBW (0.1 watt). This appears to be a reasonable limit and we strongly feel that higher power NII/SUPERNet operation should not be allowed from 5.850 to 5.875 GHz. (2) In a white paper submitted to the FCC titled "Implementing the NII Band: Suggested Technical Rules", Apple Computer, Inc. details an option for possible licensing of community networks. Included is a proposal to make licenses available only to "designated eligibles". We feel that if local and regional government agencies are the only organizations allowed to be

"designated eligibles", that they can effectively oversee installation of both DSRC and NII/SUPERNet community networks. This would facilitate informed decision-making concerning which applications are most suitable for a given geographic region, and what deployment options best meet area needs.

Though ITS may use NII/SUPERNet technology, separate DSRC systems are necessary. Many DSRC applications require guaranteed channel access. As an example, "intersection collision avoidance" is a developing technology with several proposed approaches. One of the most promising involves implementation with roadside speed- and location-sensing equipment, DSRC communication equipment, in-vehicle signing equipment and trajectory computing and control electronics. Using these components, as vehicles approach an intersection, their speed and location are compared with the traffic signal status and potential collision conditions are identified. DSRC is then used to warn drivers of danger. For example, drivers can be warned when an intersecting vehicle is about to run a red light. Moreover some older drivers have difficulty judging the speed of on-coming vehicle, when making a left turn. This system can alert drivers if there is not sufficient time to make the turn.

It is important to note that in each of these scenarios, the communication link is extremely time-sensitive. Immediate warning must be given to the driver because accident dynamics make each hundredth of a second count. In summary, it is essential that DSRC links operate with guaranteed channel access so that no excessive communication delays occur. Such guaranteed channel access is not possible with a "shared use" system such as the proposed NII/SUPERNet

In conclusion, FHWA feels that NII/SUPERNet is a worthwhile service and will have benefits to many users including the transportation industry. However, it will still be necessary to obtain additional spectrum for DSRC so that time-critical applications can be satisfied. Since both NII/SUPERNet and DSRC supporters would like to use 5.850 - 5.875 GHz, we urge the FCC to withhold the allocation of these frequencies until compatibility analysis is complete.

Attachment

DSRC Coexistence with NII/SUPERNet

1.0 Background

Currently the Federal Communications Commission (FCC) is receiving comments on a Notice of Proposed Rulemaking regarding Unlicensed National Information Infrastructure (NII)/ Shared Unlicensed Personal Radio Network (SUPERNet) Operations in the 5 GHz Frequency Range. Apple Computer, Inc. and Wireless Information Network Forum (WINForum) would like to amend Part 15 rules so that these devices can be used to support wireless Local Area Networks (LANs) at 5.15-5.35 and 5.725-5.875 GHz.

Since the top 25 MHz of this proposed allocation overlaps the 5.850-5.925 GHz frequency band which will be sought for Dedicated Short Range Communication (DSRC) operations, there is a concern that NII/SUPERNet devices may adversely affect DSRC implementation. This paper looks at the interference issue and concludes that there are compatibility issues if both types of devices are operating within 60 meters of each other.

2.0 Assumptions

It is assumed that relatively short range, commercial, DSRC applications will be operating in the 5.850-5.875 portion of the band. Examples include electronic parking payment, and drive-through applications. Electronic parking payment enables the vehicle driver to pay for parking without cash. Upon entry or exit from a parking lot a driver would have the parking charge billed or debited by passing billing and payment data across the DSRC system. Fast food establishments, dry-cleaners, car-washes, automobile repair services, and other companies which operate drive-thru operations could use DSRC technology to transfer price and payment data between the payment collection system in the building and the vehicle system.

This analysis uses information provided by Bosch on one of its systems which is capable of performing the actions mentioned above. If NII/SUPERNet devices are allowed to operate as proposed, *longer range* DSRC applications seem better suited for the 5.875-5.925 portion of the band where NII/SUPERNet interference would not be an issue.

The proposed NII/SUPERNet devices would be relatively low-powered, less than .1 watts. This analysis looks at the signal received by a DSRC beacon receiver from an NII/SUPERNet device which uses an "omni-directional" antenna. It is certainly plausible that a higher gain antenna might be utilized though it is not dealt with in this analysis. It should be noted that the DSRC antenna *is* directional. During calculation, the following parameters are used:

DSRC Equipment

beacon antenna height:	H_antenna := 2.5 m
antenna boresight elevation (see Fig. 1):	Boresight := 45 deg
antenna gain (on boresight):	G_boresight := 13.5 dB

NII/SUPERNet Emitter

emitter height:	H_emitter := 1.3 m
emitter transmit power:	P_t := .1 watt
emitter antenna gain:	G_t := 0 dB

General

transmit frequency:	f := 5.85 GHz

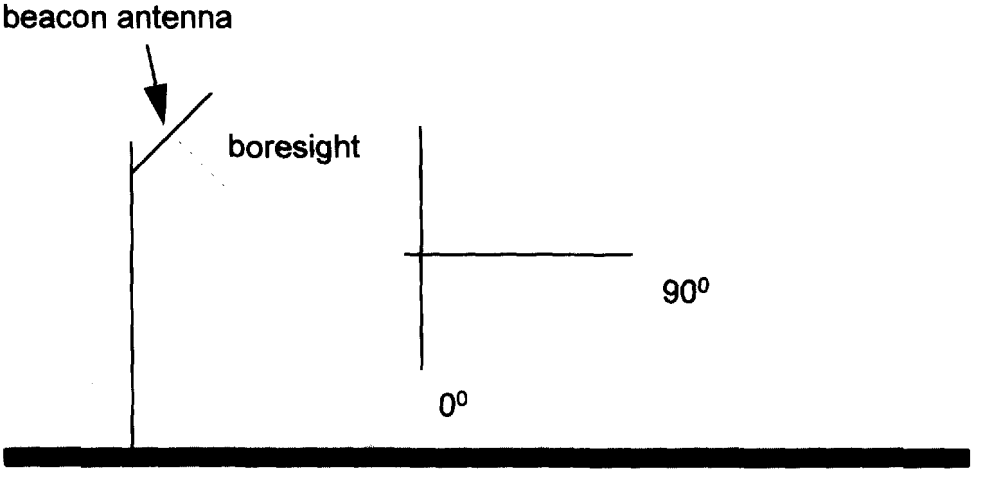

Figure 1: Beacon Antenna Configuration

The beacon antenna is directional; therefore the gain changes with both azimuth and elevation. This analysis looks at emitters that are within the 3 dB beamwidth in azimuth and can be at various distances from the receiver (i.e. variable elevation). The cases looked at are: on boresight in elevation, just outside of the main communications area, and distances where the angle above boresight approaches the horizon.

3.0 Maximum Signal Acceptable Interference Level

In order to calculate the interference potential of NII/SUPERNet devices, it is necessary to

determine the maximum signal interference level that the beacon receiver can accept. The maximum acceptable interference level (P_r_int), assuming a desired signal-to-interference ratio of 20 dB, is

P_r_int := P_r_tag - 20 P_r_tag := the maximum received signal level from the DSRC tag.

Given that the maximum tag Effective Isotropic Radiated Power (EIRP) is -24 dBm, P_r_tag can be computed using the equation for free space propagation:

$$P_r = \frac{P_t \cdot G_t \cdot G_r \cdot \lambda^2}{(4 \cdot \pi \cdot range)^2} \text{ watts}$$

This equation can be written in decibel notation as follows

$$P_r = P_t + G_t + G_r + 20 \cdot \log(\lambda) - 20 \cdot \log(4 \cdot \pi \cdot range) \text{ dBm} \quad \text{(i)}$$

where P_r _tag = P_r; P_t = -24 dBm, G_t is set to 0 dB (because P_t is given as EIRP); G_r = 13.5; and range is equal to the distance between the tag and the beacon receiver. Assuming that the tag is on boresight, the distance between the tag and the receiver antenna can be computed as follows:

$$range = \frac{H\_antenna - H\_emitter}{\cos(45)} \text{ m} = 1.697 \text{ m}$$

Therefore

P_r = -62.9 dBm and P_r_int = -82.9 dBm

4.0 Cases

4.1 Case 1, On Boresight in Elevation

For this case, the NII/SUPERNet device may be anywhere within the 3 dB beamwidth in azimuth, and the elevation angle above boresight equals 00. Since the distance between the emitter and the reader antenna will not change with azimuth, the range is 1.697 m as previously derived for the boresight case.

The antenna gain as seen by the receiver will change with changes in emitter location. This can

be represented mathematically as

$$G\_r := G\_boresight - gain\_drop\_elevation - gain\ drop\_azimuth \quad dB \quad (ii)$$

Since the emitter is seen as "on boresight" in elevation

$$gain\_drop\_elevation = 0 \quad dB$$

Since in azimuth it is assumed that the emitter is within the 3 dB beamwidth

$$gain\_drop\_azimuth = 3 \quad dB$$

Therefore G_r = 13.5 - 0 - 3 = 10.5 dB

With an NII/SUPERNet transmit power of .1 watts, equation (i) shows that the minimum interference level seen at the beacon receiver is

$$P\_r = 20\ dBm + 0 + 10.5 + 20 \cdot \log(.051) - 20 \cdot \log(4 \cdot \pi \cdot 1.697) = -21.9\ dBm$$

Obviously this is well above the maximum allowable interference level of -82.9 dBm.

4.2 Case 2, Outside of the Main Communication Area

Case 2 examines the signal strength seen from an NII/SUPERNet emitter that is located just outside of the main communication area. The Bosch access control system utilizes a communications zone which is approximately 3-4 meters long. For this interference calculation, it is assumed that the emitter is 10 meters from the reader. Range can be calculated as:

$$range := \sqrt{(H\_antenna - H\_emitter)^2 + horiz\_distance} = 10.07\ m$$

At this location, it is expected that the receiver will see at least a 15 dB drop due to elevation. Using equation (ii)

$$G\_r = 13.5 - 3 - 15 = -4.5\ dB$$

Therefore

$$P\_r = 20\ dBm + 0 + -4.5 + 20 \cdot \log(.051) - 20 \cdot \log(4 \cdot \pi \cdot 10.07) = -52.4\ dBm$$

Again this is well above the maximum allowable interference level of -82.9 dBm.

4.3 Case 3, Angle Above Boresight Approaches the Horizon

As an emitter is placed farther and farther away from the DSRC reader antenna, the look angle between the two approaches the horizon. That is to say that the reader antenna "sees" the emitter almost 450 above boresight (see Figure 1) in elevation. In order to minimize the effect of emitters outside of the communications zone, the reader antenna is built in such a way that there is a null when approaching 450 above boresight. Based upon information from Bosch, this analysis assumes that the antenna will have at least 30 dB drop when the elevation angle approaches the horizon.

Therefore, equation (ii) yields an antenna gain, as seen by the receiver, of

$$G\_r = 13.5 - 3 - 30 = -19.5 \text{ dB}$$

By re-writing equation (i) the minimum distance from the beacon receiver can be calculated as follows.

$$\text{range} = \frac{1}{4\cdot\pi}\cdot 10^{\frac{(P\_t + G\_t - G\_r - P\_r) + 20\cdot\log(\lambda)}{20}} \qquad \text{(iii)}$$

Setting

$$P\_r = P\_r\_int = -87.9 \text{ dB}$$

equation (iii) yields: range = 60.3 m

So given the assumptions listed above, an NII/SUPERNet device needs to be at least 60.3 meters away from the beacon antenna in order to maintain a Signal-to-Noise Ratio (SNR) of 20 dB.

5.0 Conclusions

This analysis has looked at the possibility of interference caused by an NII/SUPERNet device and concludes that the placement of such a device within 60 meters of a DSRC reader can cause problems. If the device is moved outside of the 3 dB azimuth beamwidth, the necessary separation distance will decrease substantially. However, this configuration is not addressed within this study because Apple and WINForum have proposed that NII/SUPERNet operations be unlicensed. As such the location of such equipment will be difficult to predict and its position outside of the 3 dB beamwidth cannot be assured.

It should be noted that Apple and WINForum anticipate that NII/SUPERNet devices would mostly be used indoors. For this situation, Case 1 does not apply because a device that operates indoors will not be within the DSRC communications zone. Case 2 may be unlikely as well. Certainly the attenuating effects of most buildings would decrease the signal level seen in Case 2, and the separation distance calculated in Case 3.

Also, the FCC has requested comment on whether or not higher powered NII/SUPERNet links should be allowed (up to 1 watt). Based upon the above discussion for devices operating at 1/10th of that power, it does not appear that higher powered links can comfortably co-exist with DSRC operations.